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AUTHOR Keuper, Sandra Mohn
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ABSTRACT

This study examined the value of the computer as an instructional tool in secondary school mathematics (grades 7-12) classrooms. The literature on the subject was reviewed and an annotated bibliography prepared with entries grouped according to effects on: (1) student achievement; (2) student attitudes; (3) teacher attitudes; (4) student learning time; and (5) special student populations. Annotations of studies reporting outcomes on more than one variable are presented under each relevant heading. Following the bibliography (which forms a major portion of the document) a summary of findings for each area is presented. These findings show that the use of the computer as an instructional tool in secondary mathematics courses has many positive and few negative effects. The positive effects include an increase of student achievement and more positive attitudes toward mathematics, the instructional setting, and the instructional method used or to be used, and also toward using the computer itself all of which, subsequently increases the students' perceptions of themselves. As a result of these and other positive effects, students generally learned more, retained more, and learned the same amount of material faster with more positive attitudes. More inservice education is recommended since some teachers expressed negative attitudes toward using computers as instructional tools. (JN)

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AN ANNOTATED BIBLIOGRAPHY OF THE EFFECTIVENESS OF THE COMPUTER USED AS A TOOL TO LEARN MATHEMATICS IN SECONDARY SCHOOLS

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by

Sandra Mohn Keuper

Graduate Student

Indiana University at South Bend
Division of Education
Exit Research Project - S591
Charles M. DuVall
June 3, 1985

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INTRODUCTION

Computers have been introduced at a fast pace into our secondary schools in the recent years. Therefore, schools have had to make a decision on how and where to best use the computer. Before schools can integrate computers into their curriculums, they must ". . . determine how this learning tool can best be implemented into the classroom." (Bohrer 1)

Background

The use of the computer as an instructional tool began as far back as the late 1950's where it was used by the computer industry to train their employees. (Burns 33) Since then, the use of the computer has expanded into our school systems at a progressing rate. The computer in the school has many uses. Among those are: 1) to present unfamiliar concepts to students; 2) to aid teachers with record keeping and testing; 3) to tutor individual students; 4) to provide drill and practice exercises; 5) to diagnose learning problems and provide remedial instruction; 6) to aid students with problem solving; 7) to promote student learning through discovery; 8) to manage complex learning situations; and 9) to increase the motivation level of students to learn. (Bell 429-430)

Chambers and Bork did a survey in 1980 of schools districts that most closely resembled the total population of U.S. public school districts. Their findings reported that 90 percent of the school districts in 1980 were using computers and was projected to rise to 94 percent in 1985. Of these school districts that used the computer, 74 percent of them used the computer for instructional purposes which was projected to rise to 87 percent in 1985. The computer was used the most by secondary mathematics departments. (50)

Statement of the Problem

The purpose of this study was to examine the value of the computer used as an instructional tool in the secondary mathematics classroom.

Study Design and Organization

This study collected studies that examined the effects of the computer used as an instructional tool in secondary courses of study and more specifically in mathematics courses. Secondary mathematics courses was defined to be mathematics courses in grades 7-12. Within the 31 studies collected, the type of computer applications varied as did the type of participants and the duration of each study. The longest study took place over three years and the shortest study lasted one day. Four of the studies collected were studies of studies previously conducted.

The study annotations to follow were divided into five sections involving the effects of the computer on student achievement, student attitudes, teacher attitudes, student learning time, and special student populations. Therefore, if a study reported outcomes on more than one of these variables, its annotation would appear more than once. Each of these five variables was also summarized separately.

Limitations

The limitations of this study were that the studies used differed in experimental design, setting, measuring instruments used, and in the types of computer applications they investigated. Not all of the studies used a control group for comparison purposes. Finally, the type of computer and computer program used and the costs involved were not taken into consideration.

Definition of Terms

computer -- "a device with self-contained memory capable of accepting information, processing the information, and outputting the results" (Spencer 15)

computer-assisted (or aided) instruction (CAI) -- "use of a computer to assist in the presentation of instructional materials to a student, to monitor learning progress, or to select additional instructional material in accordance with the needs of individual learners" (Page 80)

computer-augmented instruction -- "enhancement of student achievement through the use of the computer as an adjunct to the regular mathematics program" (Robitaillie 27)

computer-based instruction (CBI) -- a combination of computer-assisted instruction and computer-managed instruction (Kulik 19)

computer-enhanced materials -- the use of the computer and computer materials to promote and extend learning (Saunders 465)

computer-extended instruction -- see computer-assisted instruction

computer-integrated instruction (CII) -- an alternative use of CAI; the computer is not used regularly, but only when it complements rather than duplicates the instruction by the teacher or textbook (Signer 2)

computer literacy -- the understanding of the computer's capabilities, its applications, and computer algorithms (Carpenter 669)

computer-managed instruction (CMI) -- "use of a computer by a teacher or teachers to assist in classroom management and the organization of individualized learning" (Page 80)

computer program -- "a series of instructions to a computer which cause the computer to solve a problem or perform a task" (Douglas 128)

computer programming -- the study of designing computer programs (Sippl 102)

Computer Science -- "the field of knowledge that involves the design and use of computer equipment including computer program development" (Spencer 17)

drill and practice mode of CAI -- the learner responds to computer generated exercises, the computer provides feedback, and the student's level is advanced or remediated (Thomas and McClain 24)

microcomputer -- a computer reduced in size with limited speed and storage capabilities (Folk 608)

problem solving mode of CAI -- "the learner uses the computer as a complex calculator and to display data graphically" (Seltzer 373)

programmed instruction (PI) -- "instruction utilizing a workbook, textbook, or mechanical and/or electronic device programmed to help pupils attain a specified level of performance" (Good 306)

simulation mode of CAI -- the learner uses the computer to "model phenomena of an often very complex nature in which random events are introduced to add realism to the interaction" (Thomas and McClain 25)

tutorial mode of CAI -- the computer provides the learner with "paragraph-like material, interspersed questions, and response-sensitive branching" (Thomas and McClain 25)

ANNOTATIONS

Effects on Student Achievement

Burns, Patricia Knight, and William C. Bozeman. "Computer-Assisted Instruction and Mathematics Achievement: Is There a Relationship?" Educational Technology, October 1981, 32-39.

This study was a meta-analysis of 40 studies which researched the effectiveness of computer-assisted mathematics instruction on student achievement in elementary and secondary schools. In all the studies, a control group and CAI group were compared, the CAI was used as a supplement to regular instruction, and either the drill and practice or tutorial modes of CAI were employed. The overall findings showed that mathematics instruction when supplemented by CAI was significantly more effective in increasing achievement levels than traditional instruction. The findings also showed that the CAI drill and practice mode was more effective at increasing student achievement among high-ability students, disadvantaged students, boys, and at both the elementary and secondary levels. The findings on the tutorial mode showed that it was effective at increasing the achievement of disadvantaged students, and the students at both the elementary and secondary levels. These findings offered the conclusion that CAI offered a significant enhancement of mathematics learning as compared to the traditional form of learning.

"CAI Gets Credit for Dramatic Achievement Gains for Minorities." Phi Delta Kappan, December 1977, 290-291.

A 16-year decline in achievement scores in the Los Nietos, California school district was reversed by a computer-assisted instruction project. The school district's population was 80 percent minority. The project, headed by Nelson Crandall, involved providing mathematics drill and practice CAI for students after being instructed by their teachers. At the end of one year, the very low-achieving students made two years' growth in mathematics and almost the same amount of growth in reading and language arts. Besides an increase in achievement scores, truancy and tardiness were decreased. Students also showed an interest in the computers outside of the classroom by using them before and after school. Crandall based this success on the internal control that CAI taught the students. They came to realize that there was a relationship between their actions and their success.

Crawford, Alan N. "A Pilot Study of Computer-Assisted Drill and Practice in Seventh Grade Remedial Mathematics." California Journal of Educational Research, 21.4 (1970): 170-181.

The purpose of the study was to examine the value of a computer-assisted drill and practice program in supplementing remedial mathematics instruction. The participants in the study were underachieving, disadvantaged seventh grade mathematics students who were randomly assigned to a control group or a CAI group. Both groups received traditional instruction with the CAI group using the computer 3 to 15 minutes per day. All students were given a standardized achievement test as a pre- and posttest. The CAI group, parents, and staff were also given questionnaires involving the CAI program. The findings of the achievement test revealed that the CAI group significantly increased their scores from the pretest to the posttest while the control group did not. The questionnaires revealed that the CAI group had an increase in interest, had more positive attitudes toward mathematics, and felt that the computer was the most helpful instructional tool that they had used. The parents felt that the CAI program had positively affected their children. The teachers felt that the CAI program had increased the level of interest and motivation of the students involved. The major weakness of the CAI program was the machinery malfunctions.

Edwards, Judith, Shirley Norton, Sandra Taylor, Martha Weiss, and Ralph Dusseldorp. "How Effective is CAI? A Review of Research." Educational Leadership, November 1975, 147-153.

The research reviewed reported findings from 20 studies on the effectiveness of computer-assisted instruction measured by the comparison of student achievement as a result of CAI and achievement resulting from other forms of instruction. The CAI involved in the studies was in the form of drill and practice, problem solving, simulation, or tutorial instruction. When CAI was used as a supplement to traditional instruction it proved to be more effective at improving student achievement than traditional instruction. When CAI was used as a substitute for traditional instruction, nine studies showed that CAI was more effective, eight studies showed no change in achievement between CAI and non-CAI students, and three studies reported mixed findings. The studies showed evidence that one specific form of CAI was no more effective than another form of CAI. The studies also showed that CAI was equally effective on student achievement as other forms of nontraditional instruction. In regard to time reduction, all the studies showed that it took less time for the students to learn through CAI than through other methods. In the studies that measured retention time, the CAI student was shown to retain less or an equal amount of knowledge as those traditionally taught.

Fletcher, J. D., and Patrick Suppes. "The Stanford Project on Computer-Assisted Instruction for Hearing-Impaired Students." Journal of Computer-Based Instruction, 3.1 (1976): 1-12.

The major purpose of this project was to determine if CAI could benefit deaf students. More than 4000 students from 15 schools for the deaf participated in the project over a three-year period. The CAI curriculums evaluated were elementary mathematics, arithmetic word problem solving, language arts, algebra, basic English, computer programming in AID and BASIC, and logic. The approach of each of these curriculums emphasized individualization of instruction through the amount of instruction required and each student's goals. The findings showed that the performance of the deaf children was slightly better than that of normal-hearing children in most situations. More specifically, the gains in mathematics computation ability were two to three times higher than that of what was expected from classroom instruction. These data support the proposition that when the learning task does not directly involve verbal skills, the performance of deaf children is as good as the performance of normal-hearing children. The major disadvantage of CAI was its cost. However, the impact of the project was seen from the willingness of the participating schools to use their own funds to support CAI.

Gershman, Janis, and Evannah Sakamoto. "Computer-Assisted Remediation and Evaluation: A CAI Project for Ontario Secondary Schools." Educational Technology, March 1981, 40-43.

The CAI materials used in the Computer-Assisted Remediation and Evaluation project (CARE) were tested in 17 schools. The purpose of CARE was to create and evaluate CAI sequences for mathematics courses in grades 7-10. The students who participated were divided into an experimental group who used the CAI materials and a control group. Each group was given paper-and-pencil tests at the beginning of the school year and again in January. The findings of these tests showed that the students in the experimental group significantly improved their scores from the first test. They also had a substantial improvement of scores in January when compared with the control group. The use of CAI also increased the attitudes of the experimental group toward mathematics and the CARE project. The teachers' attitudes toward the CAI used were favorable. They felt that CARE increased their workload, but also increased their teaching effectiveness.

Haberman, Edward Leslie. "Effectiveness of Computer Assisted Instruction with Socially/Emotionally Disturbed Children." (Doctoral dissertation, University of Pittsburgh, 1977). Dissertation Abstracts International, 1977, 38, 1998-A.

The purpose of this study was to provide evidence that CAI offered an objective, fair, and non-threatening approach to previously frustrating learning tasks among socially or emotionally disturbed children. Eighteen of these type of students were matched in nine pairs, and randomly placed in the CAI group or non-CAI group which worked with paper and pencil. Reinforcement was provided for the CAI group by the CAI program and by the teacher for the non-CAI group. The findings revealed that grade gain scores were significantly higher in the CAI group than in the non-CAI group. The CAI group also had a higher amount of total time on task and independent time on task than the non-CAI group. The non-CAI group had a greater amount of teacher attention than the CAI group.

Harman, David J. "Kanawha County Schools/West Virginia University Teacher Corps Project. Research Report." Charleston: Kanawha County Schools, July 1980. (ERIC Document Reproduction Service No. ED 209 266).

The purpose of the study was to determine the effects of remedial methods on basic skills mathematics achievement and student attitudes toward mathematics. The remedial methods used were: 1) regular instruction; 2) regular instruction and an intern teacher; 3) regular instruction and a microcomputer; and 4) regular instruction, an intern teacher, and a microcomputer. The participants in the study were sophomores in eight general mathematics classes who were randomly assigned to one of the four remedial treatments. The results of the study showed that the students in all four treatment groups made significant gains in mathematics achievement with no specific remedial method being more productive than another. The attitude scores of treatment #3 students decreased, while the scores of treatment #4 students increased and the scores of the other two treatment groups remained the same. In the treatment #3 group, high attitude students had higher achievement scores than low attitude students. Judgments toward the worth of the microcomputer as an instructional tool could not be made because of the severe implementation problems which occurred during the study.

Hatfield, Larry Lee. "Computer-Assisted Mathematics: A Investigation of the Effectiveness of the Computer Used as a Tool to Learn Mathematics." (Doctoral dissertation, University of Minnesota, 1969). Dissertation Abstracts International, 1970, 30, 4329-4330-A.

The purpose of the study was to compare the effects of programming a computer in a seventh grade mathematics course. The two-year study involved seventh grade mathematics students who were randomly assigned to a control group or a computer group which wrote computer programs involving content taught in their mathematics couse. The measuring instruments included constructed tests, commercial standardized tests, and a selected problem solving test. During the first year, the control group performed better on the specified tests than the computer group. These results could be attributed to the interference of learning computer programming by the computer group. During the second year, the computer group made more significant gains than the control group in the areas of number theory, concept problems, and word problem solving. Students identified as high and average previous achievement students did especially well in these areas. The results of the study supported the use of computer-assisted mathematics with seventh grade students especially in the areas of number theory and problem solving. Special concern should be taken when teaching computer programming in relation to the maintenance of mathematical skills.

Henderson, Ronald W., and others. "Effects of Interactive Video/Computer Instruction on the Performance of Underachieving Students in Mathematics." Paper presented at the Annual Meeting of the American Educational Research Association, April 1983, Montreal, Canada. (ERIC Document Reproduction Service No. ED 233 690).

The purpose of the study was to test the effectiveness of instructional materials presented by a microcomputer interfaced with a video cassette recorder in teaching mathematics skills to underachieving students. The study was divided into two field trials which were exact replicas of each other except field trial 2 did not use a control group. The participants in each field trial were general mathematics and introduction to algebra students. A criterion-referenced test on factors and primes was given as a pre- and posttest to all students. Experimental students were interviewed at the end of each computer session. The criterion test yielded three scores: 1) recognition responses; 2) constructed responses; and 3) total scores. The results of the test of both field trials revealed that the experimental group had significant gains in all areas of the criterion test. The student interviews revealed mostly positive attitudes toward the instructional materials. The total results of the two field trials showed that computer/video instructional modules were effective in teaching mathematical skills and concepts to secondary school underachievers.

Hoffman, Irwin J. "Effects of Computer Application on Generalization Skills and Achievement in a Second Year Algebra Course." (Doctoral dissertation, University of Denver, 1971). Dissertation Abstracts International, 1971, 32, 2856-B.

The study involved four second year algebra classes at two metropolitan high schools. One class at each school was taught with computer application and the other two were taught in a traditional manner. The computer application was randomly assigned and involved eight computer-extended instruction units. A standardized pretest was given to all four classes to adjust for differences in algebraic preparation. This standardized test was given again as a posttest to measure achievement. A second posttest was given to measure generalization skills related to the content of the second year algebra course. The results of these posttests showed that computer-extended instruction significantly affected the achievement scores and generalization skills of the group of students which used the computer. These students were more successful in their algebra course than the students who were traditionally taught.

Jhin, Kyo Ryoon. "A Statistical Comparison of the Effectiveness of Non-tutorial Computer-Aided Instruction and Conventional Teaching of Algebra." (Doctoral dissertation, Auburn University, 1971). Dissertation Abstracts International, 1971, 32, 5734-B.

This three-month study involved four eleventh grade high school algebra II classes. One participating teacher taught the group of students which utilized the computer (56 students) and another teacher taught two control groups of 38 students. A pretest and posttest was given to each student to measure achievement in algebra, abstract reasoning, and computer knowledge. The results of these tests revealed that computer-aided instruction was: 1) as effective as conventional instruction in the achievement of algebra scores; 2) more effective than conventional instruction in the algebra achievement scores of the upper third of the eleventh grade students; 3) as effective as conventional instruction in the achievement of abstract reasoning; and 4) more effective than conventional instruction in the achievement of computer knowledge. Student attitude questionnaires revealed that computer-aided instruction increased the motivational level of the students involved, gave the students a feeling of independence, and allowed the students to recognize the significance of the computer's role in saving time.

Johnson, Warner Goodwin. "The Effects of Computer-Assisted Instruction and Programmed Instruction on the Achievement and Attitudes of Ninth Grade General Mathematics Students." (Doctoral dissertation, Temple University, 1974). Dissertation Abstracts International, 1974, 35, 1426-A.

The purpose of this study was to measure the effect of CAI on student achievement, attitude toward the instructional setting, and the time needed to complete each instructional unit by comparing a group utilizing CAI and a group utilizing a programmed instruction (PI) text. These two groups were randomly chosen from existing ninth grade general mathematics classes. A written achievement test based on the CAI was given as a pre- and posttest to measure gain scores. A CAI questionnaire was also given to measure attitudes toward the instructional setting. The findings revealed that there were no differences between the CAI group and PI group in achievement gain scores. The CAI group had a more positive attitude toward the instructional setting than the PI group. The completion time for each instructional unit was less for the CAI group. Within the CAI group, high and average ability students were able to work more quickly than low ability students. Thus, it can be concluded that students preferred CAI over PI, and CAI was more efficient in time than PI. The limitations were that the groups were composed of few females and only white lower-middle class students.

Katz, Saul M. "A Comparison of the Effects of Two Computer Augmented Methods of Instruction with Traditional Methods upon Achievement of Algebra Two Students in a Comprehensive High School." (Doctoral dissertation, Temple University, 1971). Dissertation Abstracts International, 1971, 32, 1188-1189-A.

The study involved average ability students enrolled in second year algebra classes who were randomly assigned to one of three treatment groups. These groups were the control classes which received traditional instruction, the experimental one classes which wrote computer programs, but did not run them, in conjunction with the traditional algebra instruction, and the experimental two classes which wrote and ran computer programs in conjunction with the traditional algebra instruction. The experimental two classes spent time in the computer room to run their programs during classroom instructional time. The measuring instruments used were a full year standardized test and two study-developed tests involving computer programming skills and algebra. The results of these tests showed that the experimental two classes had significantly lower scores than the other two types of classes probably due to the loss of instructional time due to computer room attendance. The study revealed that the most effective computer augmented method was computer programming with no computer access as opposed to computer programming with computer access.

Kieren, Thomas Ervin. "The Computer as a Teaching Aid of Eleventh Grade Mathematics." (Doctoral dissertation, University of Minnesota, 1968). Dissertation Abstracts International, 1969, 29, 3526-3527-A.

The purpose of the study was to examine the effects of computer programming and computer utilization on the achievement of high school mathematics students. The participants of the two-year study were eleventh grade mathematics students who were randomly assigned to a control group or a computer group who wrote computer programs and utilized the results. Over the two-year period, 20 criterion measures and sub-measures were administered. The results of the study revealed that the computer group made more significant gains than the control group on an advanced algebra test during the first year, a quadratic functions test during the second year, and on 17 of the 20 criterion measures. The control group had more significant gains than the computer group on the trigonometry unit test during the second year and on 12 of 21 items on a test on proportions. Within the computer group, the use of the computer had a more significant effect on average ability students than high ability students. The use of the computer also had a more significant effect on the learning of complex processes, organization and relation of data, and infinite processes.

Kulik, James A., Robert L. Bangert, and George W. Williams. "Effects of Computer-Based Teaching on Secondary School Students." Journal of Educational Psychology, 75.1 (1983): 19-26.

Findings from 51 separate studies on computer-based teaching in grades 6-12 were integrated by use of meta-analysis. The integrated findings on the effects of CBI involved six areas: final examination performance, retention examination performance, attitudes toward the subject matter, attitudes toward instruction, attitudes toward computers, and learning time. As a result, CBI had strong effects on student achievement levels by raising final examination scores from the 50th percentile to the 63rd percentile. It also had a positive effect on retention examination scores but not as significant. The studies which reported findings on attitudes showed an overall increase in student attitudes toward subject matter, instruction, and computers. Only two studies reported findings or learning time which showed that the computer substantially reduced the learning time. (One study had an 88% savings in learning time.) The disadvantages of this analysis involved the sources of data: each study used was separately published; the studies were not exact copies of each other; and the studies' evaluation results differed.

Maser, Arthur L., and others. "Highline Public Schools Computer-Assisted Instruction Project: A Program to Meet Disadvantaged Students' Individual Needs for Basic Skills Development: Final Report." Seattle: Highline Public Schools, June 1977. (ERIC Document Reproduction Service No. ED 167 114).

The major objective of the project was to provide an alternative approach to individual instruction for economically and educationally disadvantaged students through the use of a CAI program. Management and student outcome objectives were set before the CAI program was used. The student outcome objective involving mathematics was that students who utilized the CAI program would show a mean growth of at least one month for each month in the program. All the objectives were evaluated at the end of each year within the three-year study. In year one, all management and student outcome objectives were met. There was also a positive response towards the project shown by students, parents, and teachers. At the end of the second year, all management and student outcome objectives were met and exceeded the proposed expectations. Student and teacher involvement increased along with their more positive attitudes. The results of the evaluation of year three showed that again all objectives were met and significantly surpassed the results of the previous years. In conclusion, the study showed that the use of a CAI program for raising basic skill levels was very effective.

Menis, Yosef, Mitchell Snyder, and Ezra Ben-Kohav. "Improving Achievement in Algebra by Means of the Computer." Educational Technology, August 1980. 19-22.

The purpose of the project was to improve the mathematics attitudes and mathematics achievement levels of students who had previously received low grades in mathematics. The experiment started in 1975 and involved tenth grade algebra students who had received low mathematics grades the year before. The students used the computer to do their daily algebra assignments. The drill and practice exercises for each student were chosen by the teacher. At the end of the year, the students' achievement scores were compared with their scores received the year before. As a result, achievement averages improved over the school year and were higher than the scores of the control group. An attitudinal survey revealed that at the end of the tenth grade both groups liked mathematics less. However, the decrease in attitudes was far less significant in the computer group. So the computer group actually had less negative attitudes toward mathematics than the control group. When reviewing school records, it was found that the participants in the experiment went on to receive passing grades in mathematics throughout their years in high school.

Modisett, Douglas Mitchell. "Effects of Computer-Assisted Instruction on Achievement in Remedial Secondary Mathematical Computation." (Doctoral dissertation, Fordham University, 1980). Dissertation Abstracts International, 1980, 40, 5770-A.

This study compared two forms of supplementary remediation in mathematical computation which were a workbook and a form of CAI. The participants in the study were students in grades 9, 10, and 11 who were randomly enrolled in two or more sections of the appropriate remedial mathematics course for their grade of which one section used the workbook and the others used CAI. The achievement gains of both groups and the costs of both programs were compared. The findings revealed that during the five-month study the CAI students had an average computational growth of 10.5 months while the non-CAI group had a 4.7 month growth. The cost of the CAI program was 3.5 times more than the workbook program. However, this cost factor was reduced when the achievement gains by the CAI group were taken into consideration. It was also found that the CAI students worked almost twice as many problems per day as the non-CAI group. There was no significant difference in the computational skills between the two groups at the beginning of the study. Neither remedial method favored a specific grade level.

Robitaillie, David F., James M. Sherrill, and David M. Kaufman. "The Effect of Computer Utilization on the Achievement and Attitudes of Ninth Grade Mathematics Students." Journal for Research in Mathematics Education, 8.1 (1977): 26-32.

The purpose of the article was to report on the computer's use to enhance achievement in and attitudes toward secondary mathematics as revealed from two studies. These two studies involved a computer augmented mathematics program at the ninth-grade level in two high schools (denoted School A and School B). In each school three ninth grade algebra classes were selected where one class used the computer for the entire evaluation period, the second class used the computer the first third of the evaluation period, and the third class did not use the computer. All six classes were administered a standardized pretest and posttest to measure attitudes and achievement. The results of the four-month study in School A showed that the entire computer group scored lower than the other two groups on the achievement posttest. However, the same group had the most positive attitude toward mathematics. The results of the nine-month study in School B showed that the no computer group had the highest achievement posttest scores. There was no significant differences in attitudes among the three groups. In conclusion, neither study favored the entire computer group. However, the shorter-range study produced more positive attitudes in the entire computer group.

Ronan, Franklin Delano. "A Study of the Effectiveness of a Computer When Used as a Teaching and Learning Tool in High School Mathematics." (Doctoral dissertation, University of Michigan, 1971). Dissertation Abstracts International, 1971, 32, 1264-1265-A.

The purpose of the study was to determine if students who used a computer to learn mathematics attained a higher achievement level than those students who did not use a computer. The participants in the study were 26 algebra-trigonometry students who composed the experimental group which used the computer and 25 algebra-trigonometry students who composed the control group. Both groups were classified as average ability and taught by the same teacher. The results of the study showed that the experimental group had a higher level of achievement than the control group in the units an exponential functions and logarithms. There was no difference in achievement levels between the two groups in the units involving algebraic review materials, trigonometric functions, complex numbers, and circular functions and their inverses. The control group had a higher level of achievement than the experimental group in the units involving trigonometric identities and formulas. The experimental group also showed signficant growth in the understanding of mathematical concepts, development of mathematical skills, ability to perform mathematical problem solving, and in logic and reasoning ability.

Saunders, James, and Frederick H. Bell. "Computer-enhanced Algebra Resources: Their Effects on Achievement and Attitudes." International Journal of Mathematical Education in Science and Technology, 11.4 (1980): 465-473.

The purpose of the study was to examine the use of computer-enhanced resource materials in a second year algebra course: its effects on achievement and attitudes and its involvement with the algebra content taught in class. The eight-month study involved 101 students divided into two control sections and two experimental sections which used the computer materials. Results of the study showed that algebra achievement was not affected by the use of computer-enhanced materials. The use of the computer materials also did not affect or interfere with the regular classroom instruction. However, the groups which used the computer did have a positive increase in their attitudes towards mathematics. In summary, the use of computer-enhanced materials had no harmful effect on achievement and classroom instruction and had a positive effect on raising students' attitudes toward mathematics.

Signer, Barbara. "A Formative and Summative Evaluation of Computer Integrated Instruction." Paper presented at the CBE Research Conference, 1982. (ERIC Document Reproduction Service No. ED 224 716).

The study involved students enrolled in algebra II classes at two high schools where one implemented CII. Procedures for the formative evaluation took place at the high school where CII was implemented. They consisted of the students and teachers completing evaluation forms after each program's use, student and teacher interviews, and the completion of an attitude survey by the students. Procedures for the summative evaluation involved the administering of a pretest and posttest to all students. One of the results of the formative evaluation was that teachers recommended that CII materials should only be used for drill and practice with small groups of students probably resulting from their insecure feelings toward adapting their methods to the CII materials. Other results of the evaluation showed that teachers were reluctant to use the CII materials probably due to their lack of training and the risks involved. The lack of use of the CII materials attributed to the resulting neutral attitudes of the students toward the use of CII materials, the higher achievement by the non-CII students, and the insignificant differences between the non-CII and CII groups involving attitudes toward mathematics and the instructional setting, and computer awareness.

Thomas, David B. "The Effectiveness of Computer-Assisted Instruction Secondary Schools." AEDS Journal, 12.3 (1979): 103-116.

This review summarizes studies of achievement, attitude, retention, time savings, and costs associated with the effectiveness of computer-assisted instruction. The studies were taken from journal articles, doctoral dissertations, and unpublished literature available to the author. All the studies in the review were referenced by their author and the date of the study. In the studies that involved secondary mathematics, higher achievement scores were shown among the CAI students whether measured by teacher-made tests, standardized tests, or local tests. The attitudes of the CAI students were the same or positively higher toward their instructional situation than the non-CAI students. In the few studies that reported on retention of knowledge, the conclusions showed that the retention levels of the CAI students either increased or remained the same as the non-CAI students with the majority of the studies supporting the latter. All the studies which reported findings on learning time, agreed that CAI reduces the time it takes a student to learn a specific unit. The findings on the cost of CAI fluctuated between studies and materials used. The most valuable finding within this review was the reduced learning time of students that CAI provides.

Vincent, Albert Thomas. "The Effects of Supplementary Computer-Assisted Instruction on the Mathematics Achievement and Attitude Toward Mathematics of EMR High School Students." (Doctoral dissertation, University of Cincinnati, 1977). Dissertation Abstracts International, 1979, 39, 736-A.

This ten-week study was conducted to compare the cognitive mathematics skills of secondary Educable Mentally Retarded (EMR) students who used a CAI mathematics program with EMR students who did not use a CAI program. The attitudes toward mathematics of the EMR students who used CAI were also evaluated. The participants in the study were taken from the EMR population of two metropolitan high schools. The CAI group consisted of 31 students and the control group consisted of 39 students. Both groups of students were given the Wide Range Achievement Test as a pretest and posttest. The CAI group was also given the Spikerman Mathematics Attitude Instrument. The results of these tests revealed that the CAI group improved their cognitive mathematical skills significantly more than the non-CAI group. The school attended, race, sex or grade level had no effect on these improved scores. The CAI group also had a significantly more positive attitude toward mathematics than the non-CAI group. The school attended had no effect on these attitudes.

Effects on Student Attitudes

Beck, John J. Jr. "An Analysis of Student Attitude Toward Computer-Assisted Instruction in Nebraska Public High Schools." (Doctoral dissertation, University of Nebraska, 1979). Dissertation Abstracts International, 1979, 40, 3006-A.

This study was conducted for two purposes which were, first, to investigate the current status of CAI in Nebraska public high schools, and second, to analyze student attitudes toward CAI. The study involved 29 high schools during the 1978-1979 school year. Only 14 of these schools (264 students) provided data for analyzing attitudes. Questionnaires were administered to the students at the beginning and end of the school year. The findings of the study were: 1) CAI was predominantly used in computer science, mathematics and science courses; 2) females showed a significantly higher attitude toward CAI than males; 3) there was no significant change in attitudes toward a unit of study which used CAI; 4) there was no significant change in attitudes between females and males; and 5) there was no significnat relationships found between students' CAI attitudes and personality traits, learning style, grade point average, prior CAI experience, or amount of time on task. A small relationship occurred between CAI attitudes and personality traits. It could be concluded that CAI does not negatively affect student attitudes toward CAI or the course of study. Females and self-oriented students showed more positive attitudes toward CAI.

Beck, John J. Jr. "The Effects on Attitude of Anticipated Computer-Assisted Instruction in Selected High School Courses of Study." AEDS Journal, 12.3 (1979): 138-145.

The study compared the attitudes toward anticipated computer-assisted instruction in secondary Algebra I, American History, and Computer Science courses at two high schools. Computer Science was chosen because it was commonly offered by schools with computers. Algebra I was chosen because of its close relationship with Computer Science. Finally, American History was chosen because of its dissimilarity with the other two courses. Before the first CAI unit in each of these courses was used. the students were given a CAI attitude inventory. When compared, the students in the Computer Science course had significantly more positive attitudes toward anticipated CAI usage than the students in American History. This more positive attitude shown by the Computer Science students may be attributed to the students' perception of the learning style necessary to succeed in a specific course. Algebra I students had more positive attitudes than the American History students, and the Computer Science students had more positive attitudes than the Algebra I students, but neither comparison was significantly different. The study recommended that a computer literacy program should be provided for students prior to taking a course which uses CAI.

"CAI Gets Credit for Dramatic Achievement Gains for Minorities." Phi Delta Kappan, December 1977, 290-291.

A 16-year decline in achievement scores in the Los Nietos, California school district was reversed by a computer-assisted instruction project. The school district's population was 80 percent minority. The project, headed by Nelson Crandall, involved providing mathematics drill and practice CAI for students after being instructed by their teachers. At the end of one year, the very low-achieving students made two years' growth in mathematics and almost the same amount of growth in reading and language arts. Besides an increase in achievement scores, truancy and tardiness were decreased. Students also showed an interest in the computers outside of the classroom by using them before and after school. Crandall based this success on the internal control that CAI taught the students. They came to realize that there was a relationship between their actions and their success.

Casner, J. L. "A Study of Attitude Toward Mathematics of Eighth Grade Students Receiving Computer-Assisted Instruction and Students Receiving Conventional Classroom Instruction." (Doctoral dissertation, University of Kansas, 1977). Dissertation Abstracts International, 1978, 38, 7106-A

The procedures of the study consisted of the administering of a 20-item questionnaire about mathematics attitudes to all eighth grade students at two junior high schools where one school utilized CAI. The test was administered during English classes to minimize student bias concerning mathematics. The responses of all females, all males, and both schools were compared. There was no significant differences in attitudes toward mathematics between the CAI females and the non-CAI females. Male CAI students had significantly more positive attitudes on five of the items than the non-CAI males. Hence, it was concluded that CAI males tend to be less frightened and less nervous toward mathematics problems, disliked and dreaded mathematics less, and considered it more fun than non-CAI males. There was a significant difference between the CAI school students and the non-CAI school students on two items. The CAI students were less frightened of mathematics problems and less nervous about doing them. The results of the study were not very supportive of CAI's effects on student attitudes, but the significant differences found were positive enough to justify continued use of CAI.

Crawford, Alan N. "A Pilot Study of Computer-Assisted Drill and Practice in Seventh Grade Remedial Mathematics." California Journal of Educational Research, 21.4 (1970): 170-181.

The purpose of the study was to examine the value of a computer-assisted drill and practice program in supplementing remedial mathematics instruction. The participants in the study were underachieving, disadvantaged seventh grade mathematics students who were randomly assigned to a control group or a CAI group. Both groups received traditional instruction with the CAI group using the computer 3 to 15 minutes per day. All students were given a standardized achievement test as a pre- and posttest. The CAI group, parents, and staff were also given questionnaires involving the CAI program. The findings of the achievement test revealed that the CAI group significantly increased their scores from the pretest to the posttest while the control group did not. The questionnaires revealed that the CAI group had an increase in interest, had more positive attitudes toward mathematics, and felt that the computer was the most helpful instructional tool that they had used. The parents felt that the CAI program had positively affected their children. The teachers felt that the CAI program had increased the level of interest and motivation of the students involved. The major weakness of the CAI program was the machinery malfunctions.

DeBlassio, John K., and Frederick H. Bell. "Attitudes Toward Computers in High School Mathematics Courses." International Journal of Mathematical Education in Science and Technology, 12.1 (1981): 47-56.

The study involved the relationships between students' attitudes toward using a computer in mathematics courses and their attitudes toward mathematics, the instructional setting, their mathematics and programming achievement, programming experience, IQ, and sex. The group investigated were 220 eleventh and twelfth grade students in upper-level mathematics courses. The content of their mathematics courses was integrated with the use of the computer. The findings showed that there were positive relationships between attitudes toward using the computer and all the variables researched (mentioned above) except IQ levels and the sex of the student. Also given were the characteristics of the students who liked and those who disliked using the computer in mathematics courses.

Gershman, Janis, and Evannah Sakamoto. "Computer-Assisted Remediation and Evaluation: A CAI Project for Ontario Secondary Schools." Educational Technology, March 1981, 40-43.

The CAI materials used in the Computer-Assisted Remediation and Evaluation project (CARE) were tested in 17 schools. The purpose of CARE was to create and evaluate CAI sequences for mathematics courses in grades 7-10. The students who participated were divided into an experimental group who used the CAI materials and a control group. Each group was given paper-and-pencil tests at the beginning of the school year and again in January. The findings of these tests showed that the students in the experimental group significantly improved their scores from the first test. They also had a substantial improvement of scores in January when compared with the control group. The use of CAI also increased the attitudes of the experimental group toward mathematics and the CARE project. The teachers' attitudes toward the CAI used were favorable. They felt that CARE increased their workload, but also increased their teaching effectiveness.

Harman, David J. "Kanawha County Schools/West Virginia University Teacher Corps Project. Research Report." Charleston: Kanawha County Schools, July 1980. (ERIC Document Reproduction Service No. ED 209 266).

The purpose of the study was to determine the effects of remedial methods on basic skills mathematics achievement and student attitudes toward mathematics. The remedial methods used were: 1) regular instruction; 2) regular instruction and an intern teacher; 3) regular instruction and a microcomputer; and 4) regular instruction, an intern teacher, and a microcomputer. The participants in the study were sophomores in eight general mathematics classes who were randomly assigned to one of the four remedial treatments. The results of the study showed that the students in all four treatment groups made significant gains in mathematics achievement with no specific remedial method being more productive than another. The attitude scores of treatment #3 students decreased, while the scores of treatment #4 students increased and the scores of the other two treatment groups remained the same. In the treatment #3 group, high attitude students had higher achievement scores than low attitude students. Judgments toward the worth of the microcomputer as an instructional tool could not be made because of the severe implementation problems which occurred during the study.

Henderson, Ronald W., and others. "Effects of Interactive Video/Computer Instruction on the Performance of Underachieving Students in Mathematics." Paper presented at the Annual Meeting of the American Educational Research Association, April 1983, Montreal, Canada. (ERIC Document Reproduction Service No. ED 233 690).

The purpose of the study was to test the effectiveness of instructional materials presented by a microcomputer interfaced with a video cassette recorder in teaching mathematics skills to underachieving students. The study was divided into two field trials which were exact replicas of each other except field trial 2 did not use a control group. The participants in each field trial were general mathematics and introduction to algebra students. A criterion-referenced test on factors and primes was given as a pre- and posttest to all students. Experimental students were interviewed at the end of each computer session. The criterion test yielded three scores: 1) recognition responses; 2) constructed responses; and 3) total scores. The results of the test of both field trials revealed that the experimental group had significant gains in all areas of the criterion test. The student interviews revealed mostly positive attitudes toward the instructional materials. The total results of the two field trials showed that computer/video instructional modules were effective in teaching mathematical skills and concepts to secondary school underachievers.

Jhin, Kyo Ryoon. "A Statistical Comparison of the Effectiveness of Nontutorial Computer-Aided Instruction and Conventional Teaching of Algebra." (Doctoral dissertation, Auburn University, 1971). Dissertation Abstracts International, 1971, 32 5734-B.

This three-month study involved four eleventh grade high school algebra II classes. One participating teacher taught the group of students which utilized the computer (56 students) and another teacher taught two control groups of 38 students. A pretest and posttest was given to each student to measure achievement in algebra, abstract reasoning, and computer knowledge. The results of these tests revealed that computer-aided instruction was: 1) as effective as conventional instruction in the achievement of algebra scores; 2) more effective than conventional instruction in the algebra achievement scores of the upper third of the eleventh grade students; 3) as effective as conventional instruction in the achievement of abstract reasoning; and 4) more effective than conventional instruction in the achievement of computer knowledge. Student attitude questionnaires revealed that computer-aided instruction increased the motivational level of the students involved, gave the students a feeling of independence, and allowed the students to recognize the significance of the computer's role in saving time.

Johnson, Warner Goodwin. "The Effects of Computer-Assisted Instruction and Programmed Instruction on the Achievement and Attitudes of Ninth Grade General Mathematics Students." (Doctoral dissertation, Temple University. 1974). Dissertation Abstracts International, 1974, 35, 1426-A.

The purpose of this study was to measure the effect of CAI on student achievement, attitude toward the instructional setting, and the time needed to complete each instructional unit by comparing a group utilizing CAI and a group utilizing a programmed instruction (PI) text. These two groups were randomly chosen from existing ninth grade general mathematics classes. A written achievement test based on the CAI was given as a pre- and posttest to measure gain scores. A CAI questionnaire was also given to measure attitudes toward the instructional setting. The findings revealed that there were no differences between the CAI group and PI group in achievement gain scores. The CAI group had a more positive attitude toward the instructional setting than the PI group. The completion time for each instructional unit was less for the CAI group. Within the CAI group, high and average ability students were able to work more quickly than low ability students. Thus, it can be concluded that students preferred CAI over PI, and CAI was more efficient in time than PI. The limitations were that the groups were composed of few females and only white lower-middle class students.

Kulik, James A., Robert L. Bangert, and George W. Williams. "Effects of Computer-Based Teaching on Secondary School Students." Journal of Educational Psychology, 75.1 (1983): 19-26.

Findings form 51 separate studies on computer-based teaching in grades 6-12 were integrated by use of meta-analysis. The integrated findings on the effects of CBI involved six areas: final examination performance, retention examination performance, attitudes toward the subject matter, attitudes toward instruction, attitudes toward computers, and learning time. As a result, CBI had strong effects on student achievement levels by raising final examination scores from the 50th percentile to the 63rd percentile. It also had a positive effect on retention examination scores but not as significant. The studies which reported findings on attitudes showed an overall increase in student attitudes toward subject matter, instruction, and computers. Only two studies reported findings on learning time which showed that the computer substantially reduced the learning time. (One study had an 88% savings in learning time.) The disadvantages of this analysis involved the sources of data: each study used was separately published; the studies were not exact copies of each other; and the studies' evaluation results differed.

Maser, Arthur L., and others. "Highline Public Schools Computer-Assisted Instruction Project: A Program to Meet Disadvantaged Students' Individual Needs for Basic Skills Development: Final Report." Seattle: Highline Public Schools, June 1977. (ERIC Document Reproduction Service No. ED 167 114).

The major objective of the project was to provide an alternative approach to individual instruction for economically and educationally disadvantaged students through the use of a CAI program. Management and student outcome objectives were set before the CAI program was used. The student outcome objective involving mathematics was that students who utilized the CAI program would show a mean growth of at least one month for each month in the program. All the objectives were evaluated at the end of each year within the three-year study. In year one, all management and student outcome objectives were met. There was also a positive response towards the project shown by students, parents, and teachers. At the end of the second year, all management and student outcome objectives were met and exceeded the proposed expectations. Student and teacher involvement increased along with their more positive attitudes. The results of the evaluation of year three showed that again all objectives were met and significantly surpassed the results of the previous years. In conclusion, the study showed that the use of a CAI program for raising basic skill levels was very effective.

Menis, Yosef, Mitchell Snyder, and Ezra Ben-Kohav. "Improving Achievement in Algebra by Means of the Computer." Educational Technology, August 1980, 19-22.

The purpose of the project was to improve the mathematic attitudes and mathematics achievement levels of students who had previously received low grades in mathematics. The experiment started in 1975 and involved tenth grade algebra students who had received low mathematics grades the year before. The students used the computer to do their daily algebra assignments. The drill and practice exercises for each student were chosen by the teacher. At the end of the year, the students' achievement scores were compared with their scores received the year before. As a result, achievement averages improved over the school year and were higher than the scores of the control group. An attitudinal survey revealed that at the end of the tenth grade both groups liked mathematics less. However, the decrease in attitudes was far less significant in the computer group. So the computer group actually had less negative attitudes toward mathematics than the control group. When reviewing school records, it was found that the participants in the experiment went on to receive passing grades in mathematics throughout their years in high school.

Robitaillie, David F., James M. Sherrill, and David M. Kaufman. "The Effect of Computer Utilization on the Achievement and Attitudes of Ninth Grade Mathematics Students." Journal for Research in Mathematics Education, 8.1 (1977): 26-32.

The purpose of the article was to report on the computer's use to enhance achievement in and attitudes toward secondary mathematics as revealed from two studies. These two studies involved a computer augmented mathematics program at the ninth-grade level in two high schools (denoted School A and School B). In each school three ninth grade algebra classes were selected where one class used the computer for the entire evaluation period, the second class used the computer the first third of the evaluation period, and the third class did not use the computer. All six classes were administered a standardized pretest and posttest to measure attitudes and achievement. The results of the four-month study in School A showed that the entire computer group scored lower than the other two groups on the achievement posttest. However, the same group had the most positive attitude toward mathematics. The results of the nine-month study in School B showed that the no computer group had the highest achievement posttest scores. There was no significant differences in attitudes among the three groups. In conclusion, neither study favored the entire computer group. However, the shorter-range study produced more positive attitudes in the entire computer group.

Saunders, James, and Frederick H. Bell. "Computer-enhanced Algebra Resources: Their Effects on Achievement and Attitudes." International Journal of Mathematical Education in Science and Technology, 11.4 (1980): 465-473.

The purpose of the study was to examine the use of computer-enhanced resourse materials in a second year algebra course: its effects on achievement and attitude and its involvement with the algebra content taught in class. The eight-month study involved 101 students divided into two control sections and two experimental sections which used the computer materials. Results of the study showed that algebra achievement was not affected by the use of computer-enhanced materials. The use of the computer materials also did not affect or interfere with the regular classroom instruction. However, the groups which used the computer did have a positive increase in their attitudes towards mathematics. In summary, the use of computer-enhanced materials had no harmful effect on achievement and classroom instruction and had a positive effect on raising students' attitudes toward mathematics.

Sherzer, Bill. "Where are the Computers?" The Computing Teacher, May 1979, 6-9.

The study reported on findings from four high schools on their present computer usage, students reactions to computer terminals, present teacher usage of computer terminals, and administrator views on the use of computers. The present usage of computers in the four high schools was found to be very modest. A geometry class from one high school was chosen for observation of student reactions. The measuring instruments used were an attitudinal survey and modification of SCORe (Seating Chart Observational Recordings). The SCORe procedure revealed that only 50-75 percent of the students assigned to used the computer did so within the homework period, and 100 percent of the students who did use the computers were on task the entire time. These results showed that the computer was a very useful instructional tool if the students accepted it. The teachers at the four schools did not readily use the computer for these reasons: 1) not enough time to incorporate the computer into their lesson plans; 2) the inaccessability of computers for non-mathematics teachers; and 3) the teachers did not feel competent enough to use the computer. In the opinion of the administrators, computers were good instructional tools, but were too costly and not readily accepted by the public.

Signer, Barbara. "A Formative and Summative Evaluation of Computer Integrated Instruction." Paper presented at the CBE Research Conference, 1982. (ERIC Document Reproduction Service No. ED 224 716).

The study involved students enrolled in algebra II classes at two high schools where one implemented CII. Procedures for the formative evaluation took place at the high school where CII was implemented. They consisted of the students and teachers completing evaluation forms after each program's use, student and teacher interviews, and the completion of an attitude survey by the students. Procedures for the summative evaluation involved the administering of a pretest and posttest to all students. One of the results of the formative evaluation was that teachers recommended that CII materials should only be used for drill and practice with small groups of students probably resulting from their insecure feelings toward adapting their methods to the CII materials. Other results of the evaluation showed that teachers were reluctant to use the CII materials probably due to their lack of training and the risks involved. The lack of use of the CII materials attributed to the resulting neutral attitudes of the students toward the use of CII materials, the higher achievement by the non-CII students, and the insignificant differences between the non-CII and CII groups involving attitudes toward mathematics and the instructional setting, and computer awareness.

Smith, Ian D. "Impact of Computer-Assisted Instruction on Student Attitudes." Journal of Educational Psychology, 64.3 (1973): 366-372.

The purpose of the study was to investigate the effect of computer-assisted instruction in mathematics on student attitudes of self-concept, locus of control, and level of aspiration. Locus of control was defined as a person's beliefs about whether the responsibilities of reinforcement come from himself or outside factors. Level of aspiration was defined as the expected standard of performance on a given task. The participants in the study were seventh, eighth, and ninth grade student who performed 2 to 3 years below grade level in mathematics. Two self-concept inventories, a locus of control instrument, and a level of aspiration task were administered to the students as pre- and posttests. The results of these testing measures revealed that student self-concept and locus of control did not increase from pretest to posttest. However, the non-CAI group had more stable attitudes than the CAI group. It was also found that the posttest self-concept scores of the CAI group were significantly related to their mathematics achievement scores. In conclusion, CAI was effective at alining students' self-concept with their mathematics achievenent which also made their aspiration levels realistic. The main limitations of the study were that the CAI and non-CAI groups were not randomly assigned and the students were 75 percent Mexican-American.

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Effects on Student Learning Time

Edwards, Judith, Shirley Norton, Sandra Taylor, Martha Weiss, and Ralph Dusseldorp. "How Effective is CAI? A Review of Research." Educational Leadership, November 1975, 147-153.

The research reviewed reported findings from 20 studies on the effectiveness of computer-assisted instruction measured by the comparison of student achievement as a result of CAI and achievement resulting from other forms of instruction. The CAI involved in the studies was in the form of drill and practice, problem solving, simulation, or tutorial instruction. When CAI was used as a supplement to traditional instruction it proved to be more effective at improving student achievement than traditional instruction. When CAI was used as a substitute for traditional instruction, nine studies showed that CAI was more effective, eight studies showed no change in achievement between CAI and non-CAI students, and three studies reported mixed findings. The studies showed evidence that one specific form of CAI was no more effective than another form of CAI. The studies also showed that CAI was equally effective on student achievement as other forms of nontraditional instruction. In regard to time reduction, all the studies showed that it took less time for the students to learn through CAI than through other methods. In the studies that measured retention time, the CAI student was shown to retain less or an equal amount of knowledge as those traditionally taught.

Haberman, Edward Leslie. "Effectiveness of Computer Assisted Instruction with Socially/Emotionally Disturbed Children." (Doctoral dissertation, University of Pittsburgh, 1977). Dissertation Abstracts International, 1977, 38, 1998-A.

The purpose of this study was to provide evidence that CAI offered an objective, fair, and non-threatening approach to previously frustrating learning tasks among socially or emotionally disturbed children. Eighteen of these type of students were matched in nine pairs, and randomly placed in the CAI group or non-CAI group which worked with paper and pencil. Reinforcement was provided for the CAI group by the CAI program and by the teacher for the non-CAI group. The findings revealed that grade gain scores were significantly higher in the CAI group than in the non-CAI group. The CAI group also had a higher amount of total time on task and independent time on task than the non-CAI group. The non-CAI group had a greater amount of teacher attention than the CAI group.

Kulik, James A., Robert L. Bangert, and George W. Williams. "Effects of Computer-Based Teaching on Secondary School Students." Journal of Educational Psychology, 75.1 (1983): 19-26.

Findings from 51 separate studies on computer-based teaching in grades 6-12 were integrated by use of meta-analysis. The integrated findings on the effects of CBI involved six areas: final examination performance, retention examination performance, attitudes toward the subject matter, attitudes toward instruction, attitudes toward computers, and learning time. As a result, CBI had strong effects on student achievement levels by raising final examination scores from the 50th percentile to the 63rd percentile. It also had a positive effect on retention examination scores but not as significant. The studies which reported findings on attitudes showed an overall increase in student atttitudes toward subject matter, instruction, and computers. Only two studies reported findings on learning time which showed that the computer substantially reduced the learning time. (One study had an 88% savings in learning time.) The disadvantages of this analysis involved the sources of data: each study used was separately published; the studies were not exact copies of each other; and the studies' evaluation results differed.

Modisett, Douglas Mitchell. "Effects of Computer-Assisted Instruction on Achievement in Remedial Secondary Mathematical Computation." (Doctoral dissertation, Fordham University, 1980). Dissertation Abstracts International, 1980, 40, 5770-A.

This study compared two forms of supplementary remediation in mathematical computation which were a workbook and a form of CAI. The participants in the study were students in grades 9, 10 and 11 who were randomly enrolled in two or more sections of the appropriate remedial mathematics course for their grade of which one section used the work book and the others used CAI. The achievement gains of both groups and the costs of both programs were compared. The findings revealed that during the five-month study the CAI students had an average computational growth of 10.5 months while the non-CAI group had a 4.7 month growth. The cost of the CAI program was 3.5 times more than the workbook program. However, this cost factor was reduced when the achievement gains by the CAI group were taken into consideration. It was also found that the CAI students worked almost twice as many problems per day as the non-CAI group. There was no significant difference in the computational skills between the two groups at the beginning of the study. Neither remedial method favored a specific grade level.

Thomas, David B. "The Effectiveness of Computer-Assisted Instruction Secondary Schools." AEDS Journal, 12.3 (1979): 103-116.

This review summarizes studies of achievement, attitude, retention, time savings, and costs associated with the effectiveness of computer-assisted instruction. The studies were taken from journal articles, doctoral dissertations, and unpublished literature available to the author. All the studies in the review were referenced by their author and the date of the study. In the studies that involved secondary mathematics, higher achievement scores were shown among the CAI students whether measured by teacher-made tests, standardized tests, or local tests. The attitudes of the CAI students were the same or positively higher toward their instructional situation than the non-CAI students. In the few studies that reported on retention of knowledge, the conclusions showed that the retention levels of the CAI students either increased or remained the same as the non-CAI students with the majority of the studies supporting the latter. All the studies which reported findings on learning time, agreed that CAI reduces the time it takes a student to learn a specific unit. The findings on the cost of CAI fluctuated between studies and materials used. The most valuable finding within this review was the reduced learning time of students that CAI provides.

Effects on Special Student Populations

Burns, Patricia Knight, and William C. Bozeman. "Computer-Assisted Instruction and Mathematics Achievement: Is There a Relationship?" Educational Technology, October 1981, 32-39.

This study was a meta-analysis of 40 studies which researched the effectiveness of computer-assisted mathematics instruction on student achievement in elementary and secondary schools. In all the studies, a control group and CAI group were compared, the CAI was used as a supplement to regular instruction, and either the drill and practice or tutorial modes of CAI were employed. The overall findings showed that mathematics instruction when supplemented by CAI was significantly more effective in increasing achievement levels than traditional instruction. The findings also showed that the CAI drill and practice mode was more effective at increasing student achievement among high-ability students, disadvantaged students, boys, and at both the elementary and secondary levels. The findings on the tutorial mode showed that it was effective at increasing the achievement of disadvantaged students, and the students at both the elementary and secondary levels. These findings offered the conclusion that CAI offered a significant enhancement of mathematics learning as compared to the traditional form of learning.

"CAI Gets Credit for Dramatic Achievement Gains for Minorities." Phi Delta Kappan, December 1977, 290-291.

A 16-year decline in achievement scores in the Los Nietos, California school district was reversed by a computer-assisted instruction project. The school district's population was 80 percent minority. The project, headed by Nelson Crandall, involved providing mathematics drill and practice CAI for students after being instructed by their teachers. At the end of one year, the very low-achieving students made two years' growth in mathematics and almost the same amount of growth in reading and language arts. Besides an increase in achievement scores, truancy and tardiness were decreased. Students also showed an interest in the computers outside of the classroom by using them before and after school. Crandall based this success on the internal control that CAI taught the students. They came to realize that there was a relationship between their actions and their success.

Crawford, Alan N. "A Pilot Study of Computer-Assisted Drill and Practice in Seventh Grade Remedial Mathematics." California Journal of Educational Research, 21.4 (1970): 170-181.

The purpose of the study was to examine the value of a computer-assisted drill and practice program in supplementing remedial mathematics instruction. The participants in the study were underachieveing, disadvantaged seventh grade mathematics students who were randomly assigned to a control group or a CAI group. Both groups received traditional instruction with the CAI group using the computer 3 to 15 minutes per day. All students were given a standardized achievement test as a pre- and posttest. The CAI group, parents, and staff were also given questionnaires involving the CAI program. The findings of the achievement test revealed that the CAI group significantly increased their scores from the pretest to the posttest while the control group did not. The questionnaires revealed that the CAI group had an increase in interest, had more positive attitudes toward mathematics, and felt that the computer was the most helpful instructional tool that they had used. The parents felt that the CAI program had positively affected their children. The teachers felt that the CAI program had increased the level of interest and motivation of the students involved. The major weakness of the CAI program was the machinery malfunctions.

Fletcher, J. D., and Patrick Suppes. "The Stanford Project on Computer-Assisted Instruction for Hearing-Impaired Students." Journal of Computer-Based Instruction, 3.1 (1976): 1-12.

The major purpose of this project was to determine if CAI could benefit deaf students. More than 4000 students from 15 schools for the deaf participated in the project over a three-year period. The CAI curriculums evaluated were elementary mathematics, arithmetic word problem solving, language arts, algebra, basic English, computer programming in AID and BASIC, and logic. The approach of each of these curriculums emphasized individualization of instruction through the amount of instruction required and each student's goals. The findings showed that the performance of the deaf children was slightly better than that of normal-hearing children in most situations. More specifically, the gains in mathematics computation ability were two to three times higher than that of what was expected from classroom instruction. These data support the proposition that when the learning task does not directly involve verbal skills, the performance of deaf children is as good as the performance of normal-hearing children. The major disadvantage of CAI was its cost. However, the impact of the project was seen from the willingness of the participating schools to use their own funds to support CAI.

Gershman, Janis, and Evannah Sakamoto. "Computer-Assisted Remediation and Evaluation: A CAI Project for Ontario Secondary Schools." Educational Technology, March 1981, 40-43.

The CAI materials used in the Computer-Assisted Remediation and Evaluation project (CARE) were tested in 17 schools. The purpose of CARE was to create and evaluate CAI sequences for mathematics courses in grades 7-10. The students who participated were divided into an experimental group who used the CAI materials and a control group. Each group was given paper-and-pencil tests at the beginning of the school year and again in January. The findings of these tests showed that the students in the experimental group significantly improved their scores from the first test. They also had a substantial improvement of scores in January when compared with the control group. The use of CAI also increased the attitudes of the experimental group toward mathematics and the CARE project. The teachers' attitudes toward the CAI used were favorable. They felt that CARE increased their workload, but also increased their teaching effectiveness.

Haberman, Edward Leslie. "Effectiveness of Computer Assisted Instruction with Socially/Emotionally Disturbed Children." (Doctoral dissertation, University of Pittsburgh, 1977). Dissertation Abstracts International, 1977, 38, 1998-A.

The purpose of this study was to provide evidence that CAI offered an objective, fair, and non-threatening approach to previously frustrating learning tasks among socially or emotionally disturbed children. Eighteen of these types of students were matched in nine pairs, and randomly placed in the CAI group or non-CAI group which worked with paper and pencil. Reinforcement was provided for the CAI group by the CAI program and by the teacher for the non-CAI group. The findings revealed that grade gain scores were significantly higher in the CAI group than in the non-CAI group. The CAI group also had a higher amount of total time on task and independent time on task than the non-CAI group. The non-CAI group had a greater amount of teacher attention than the CAI group.

Harman, David J. "Kanawha County Schools/West Virginia University Teacher Corps Project. Research Report." Charleston: Kanawha County Schools, July 1980. (ERIC Document Reproduction Service No. ED 209 266).

The purpose of the study was to determine the effects of remedial methods on basic skills mathematics achievement and student attitudes toward mathematics. The remedial methods used were: 1) regular instruction; 2) regular instruction and an intern teacher; 3) regular instruction and a microcomputer; and 4) regular instruction, an intern teacher, and a microcomputer. The participants in the study were sophomores in eight general mathematics classes who were randomly assigned to one of the four remedial treatments. The results of the study showed that the students in all four treatment groups made significant gains in mathematics achievement with no specific remedial method being more productive than another. The attitude scores of treatment #3 students decreased, while the scores of treatment #4 students increased and the scores of the other two treatment groups remained the same. In the treatment #3 group, high attitude students had higher achievement scores than low attitude students. Judgments toward the worth of the microcomputer as an instructional tool could not be made because of the severe implementation problems which occurred during the study.

Henderson, Ronald W., and others. "Effects of Interactive Video/Computer Instruction on the Performance of Underachieving Students in Mathematics." Paper presented at the Annual Meeting of the American Educational Research Association, April 1983, Montreal, Canada. (ERIC Document Reproduction Service No. ED 233 690).

The purpose of the study was to test the effectiveness of instructional materials presented by a microcomputer interfaced with a video cassette recorder in teaching mathematics skills to underachieving students. The study was divided into two field trials which were exact replicas of each other except field trial 2 did not use a control group. The participants in each field trial were general mathematics and introduction to algebra students. A criterion-referenced test on factors and primes was given as a pre- and posttest to all students. Experimental students were interviewed at the end of each computer session. The criterion test yielded three scores: 1) recognition responses; 2) constructed responses; and 3) total scores. The results of the test of both field trials revealed that the experimental group had significant gains in all areas of the criterion test. The student interviews revealed mostly positive attitudes toward the instructional materials. The total results of the two field trials showed that computer/video instructional modules were effective in teaching mathematical skills and concepts to secondary school underachievers.

Johnson, Warner Goodwin. "The Effects of Computer-Assisted Instruction and Programmed Instruction on the Achievement and Attitudes of Ninth Grade General Mathematics Students." (Doctoral dissertation, Temple University, 1974). Dissertation Abstracts International, 1974, 35, 1426-A.

The purpose of this study was to measure the effect of CAI on student achievement, attitude toward the instructional setting, and the time needed to complete each instructional unit by comparing a group utilizing CAI and a group utilizing a programmed instruction (PI) text. These two groups were randomly chosen from existing ninth grade general mathematics classes. A written achievement test based on the CAI was given as a pre- and posttest to measure gain scores. A CAI questionnaire was also given to measure attitudes toward the instructional setting. The findings revealed that there were no differences between the CAI group and PI group in achievement gain scores. The CAI group had a more positive attitude toward the instructional setting than the PI group. The completion time for each instructional unit was less for the CAI group. Within the CAI group, high and average ability students were able to work more quickly than low ability students. Thus, it can be concluded that students preferred CAI over PI, and CAI was more efficient in time than PI. The limitations were that the groups were composed of few females and only white lower-middle class students.

Maser, Arthur L., and others. "Highline Public Schools Computer-Assisted Instruction Project: A Program to Meet Disadvantaged Students' Individual Needs for Basic Skills Development: Final Report." Seattle: Highline Public Schools, June 1977. (ERIC Document Reproduction Service No. ED 167 114).

The major objective of the project was to provide an alternative approach to individual instruction for economically and educationally disadvantaged students through the use of a CAI program. Management and student outcome objectives were set before the CAI program was used. The student outcome objective involving mathematics was that students who utilized the CAI program would show a mean growth of at least one month for each month in the program. All the objectives were evaluated at the end of each year within the three-year study. In year one, all management and student outcome objectives were met. There was also a positive response towards the project shown by students, parents, and teachers. At the end of the second year, all management and student outcome objectives were met and exceeded the proposed expectations. Student and teacher involvement increased along with their more positive attitudes. The results of the evaluation of year three showed that again all objectives were met and significnatly surpassed the results of the previous years. In conclusion, the study showed that the use of a CAI program for raising basic skill levels was very effective.

Menis, Yosef, Mitchell Snyder, and Ezra Ben-Kohav. "Improving Achievement in Algebra by Means of the Computer." Educational Technology, August 1980, 19-22.

The purpose of the project was to improve the mathematics attitudes and mathematics achievement levels of students who had previously received low grades in mathematics. The experiment started in 1975 and involved tenth grade algebra students who had received low mathematics grades the year before. The students used the computer to do their daily algebra assignments. The drill and practice exercises for each student were chosen by the teacher. At the end of the year, the students' achievement scores were compared with their scores received the year before. As a result, achievement averages improved over the school year and were higher than the scores of the control group. An attitudinal survey revealed that at the end of the tenth grade both groups liked mathematics less. However, the decrease in attitudes was far less significant in the computer group. So the computer group actually had less negative attitudes toward mathematics than the control group. When reviewing school records, it was found that the participants in the experiment went on to receive passing grades in mathematics throughout their years in high school.

Modisett, Douglas Mitchell. "Effects of Computer-Assisted Instruction on Achievement in Remedial Secondary Mathematical Computation." (Doctoral dissertation, Fordham University, 1980). Dissertation Abstracts International, 1980, 40, 5770-A.

This study compared two forms of supplementary remediation in mathematical computation which were a workbook and a form of CAI. The participants in the study were students in grades 9, 10 and 11 who were randomly enrolled in two or more sections of the appropriate remedial mathematics course for their grade of which one section used the workbook and the others used CAI. The achievement gains of both groups and the costs of both programs were compared. The findings revealed that during the five-month study the CAI students had an average computational growth of 10.5 months while the non-CAI group had a 4.7 month growth. The cost of the CAI program was 3.5 times more than the workbook program. However, this cost factor was reduced when the achievement gains by the CAI group were taken into consideration. It was also found that the CAI students worked almost twice as many problems per day as the non-CAI group. There was no significant difference in the computational skills between the two groups at the beginning of the study. Neither remedial method favored a specific grade level.

Smith, Ian D. "Impact of Computer-Assisted Instruction on Student Attitudes." Journal of Educational Psychology, 64.3 (1973): 366-372.

The purpose of the study was to investigate the effect of computer-assisted instruction in mathematics on student attitudes of self-concept, locus of control, and level of aspiration. Locus of control was defined as a person's beliefs about whether the responsibilities of reinforcement come from himself or outside factors. Level of aspiration was defined as the expected standard of performance on a given task. The participants in the study were seventh, eighth, and ninth grade students who performed 2 to 3 years below grade level in mathematics. Two self-concept inventories, a locus of control instrument, and a level of aspiration task were administered to the students as pre- and posttests. The results of these testing measures revealed that student self-concept and locus of control did not increase from pretest to posttest. However, the non-CAI group had more stable attitudes than the CAI group. It was also found that the posttest self-concept scores of the CAI group were significantly related to their mathematics achievement scores. In conclusion, CAI was effective at alining students' self-concept with their mathematics achievement which also made their aspiration levels realistic. The main limitations of the study were that the CAI and non-CAI groups were not randomly assigned and the students were 75 percent Mexican-American.

Vincent, Albert Thomas. "The Effects of Supplementary Computer-Assisted Instruction on the Mathematics Achievement and Attitude Toward Mathematics of EMR High School Students." (Doctoral dissertation, University of Cincinnati, 1977). Dissertation Abstracts International, 1979, 39, 736-A.

This ten-week study was conducted to compare the cognitive mathematics skills of secondary Educable Mentally Retarded (EMR) students who used a CAI mathematics program with EMR students who did not use a CAI program. The attitudes toward mathematics of the EMR students who used CAI were also evaluated. The participants in the study were taken from the EMR population of two metropolitan high schools. The CAI group consisted of 31 students and the control group consisted of 39 students. Both groups of students were given the Wide Range Achievement Test as a pretest and posttest. The CAI group was also given the Spikerman Mathematics Attitude Instrument. The results of these tests revealed that the CAI group improved their cognitive mathematical skills significantly more than the non-CAI group. The school attended, race, sex or grade level had no effect on these improved scores. The CAI group also had a significantly more positive attitude toward mathematics than the non-CAI group. The school attended had no effect on these attitudes.

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary - Effects on Student Achievement

Out of the 25 studies that reported findings on student achievement, 20 studies showed that the computer used as an instructional tool had positive effects on student mathematics achievement. Four of these studies (Fletcher, Harman, Maser, and Menis) compared the data obtained from the computer group with individual past achievement performance or expected achievement performance rather than with data obtained from a control group. In each case the students improved their individual achievement scores or exceeded the expected outcomes. However, in the study by Harman judgments toward the worth of the microcomputer as an instructional tool could not be made because of implementation problems. In the studies that used a control group for comparison purposes, general mathematics achievement gains were shown in the studies by Burns, "CAI Gets Credit ...", Crawford, Edwards, Gershman, Haberman, Hoffman, Kulik, Modisett, Thomas, and Vincent. Specific mathematics achievement gains were shown in the following areas: algebra achievement of the upper third of the computer group (Jhin); number theory, concept problems, and word problem solving (Hatfield); recognition and constructed responses on criterion tests involving factors and primes (Henderson); advanced algebra and quadratic functions (Kieren); and exponential functions, logarithms, mathematical concepts, development of problem solving skills, and logic and reasoning ability (Ronan). In all of these studies previously mentioned, the computer used as an instructional tool proved to offer a significant enhancement to mathematics learning.

The results of four studies showed that the computer had no effect on the mathematics achievement of the students involved. In the study by Jhin, the use of the computer had no effect on algebra achievement scores for the entire computer group and abstract reasoning ability. Johnson reported findings on the comparison of a CAI group and PI group which revealed no differences in mathematics gain scores between the two groups. The computer had no effect in the areas of algebraic review materials, trigonometric functions, complex numbers, and circular functions and inverses as revealed in the study by Ronan. Finally, the use of computer-enhanced resource materials had no effect on the mathematics achievement of the computer group as reported by Saunders. These four studies showed that the use of the computer as an instructional tool was just as effective as other forms of instruction.

The use of the computer had negative effects on those students involved in six studies. In the studies by Kieren and Ronan, the control group performed better than the computer group in the areas of trigonometry and proportions, and trigonometic identities and formulas respectively. The control group had a better overall performance during the first year of the study by Hatfield. This was attributed to the interference of learning programming skills by the computer group. The control group in the study by Signer also attained higher achievement results than the computer group. However, these results were attributed to the lack of use of the computer materials by the computer group. The two studies that used a computer-augmented approach to instruction, Katz and Robitaillie, revealed unfavorable results concerning the computer group. In the study by Katz, the group that wrote and ran their own computer programs had lower achievement scores than the group that

just wrote computer programs and the group that did not use the computer. These lower scores were attributed to the loss of instructional time by the group to run their computer programs. The study by Robitaillie involved two schools and three groups of students at each school. The study at School A revealed that the group that used the computer the duration of the study had lower achievement scores than the group that used the computer during the first third of the study and the group that did not use the computer. The study at School B revealed that the group that did not use the computer had the highest achievement scores. The group that used the computer the entire time was not favored in either study.

Summary - Effects on Student Attitudes

In the 12 studies that measured students' attitudes toward mathematics, only two studies reported a decrease in attitudes as a result of using the computer as an instructional tool. The decrease in attitudes in the study by Harman occurred in the remedial treatment group that was exposed to regular instruction and the use of a microcomputer. This study experienced microcomputer implementation problems. In the study by Henis both the computer group and the control group showed a decrease in attitudes toward mathematics. However, the decrease shown by the computer group was far less significant than the decrease shown by the control group. This could be restated that the computer group had a less negative attitude toward mathematics than the control group. The use of the computer had no effect on attitudes toward mathematics in the following studies: Beck ("An Analysis..."); Casner - females and

both schools involved; Harman - the treatment groups that had regular instruction or regular instruction with the aid of an intern teacher; Robitaillie - School B; and Signer. Eight of the studies reported positive increases in attitudes toward mathematics. These studies were those conducted by Casner - males, Crawford, Gershman, Harman - the remedial treatment group that had regular instruction with the aid of an intern teacher and a microcomputer, Kulik, Robitaillie - School A, Saunders, and Vincent.

In the 10 studies that measured the students' attitudes toward the instructional setting or the instructional method used or to be used, all of them resulted in the attitudes of the computer group either positively increasing or remaining the same. The students' attitudes toward the instructional method remained the same in the studies by Signer and Thomas. The studies that showed a positive increase in attitudes were Beck ("An Analysis..."), Beck ("The Effects..."), Gershman, Henderson, Jhin, Johnson, Kulik, Maser, and Thomas.

Five studies ("CAI Gets Credit...", Crawford, Gershman, Kulik, and Sherzer) reported findings on the attitudes of students toward using the computer. Of these five studies, all but one of them reported positive effects. The somewhat negative results were reported in the study by Sherzer. Only 50-75 percent of the students assigned to use the computer did so. However, of those students which did use the computer, all of them were on task the entire time. Attitudes toward using the computer were not technically measured in the study "CAI Gets Credit..." and in the study by Crawford but in both cases the participating students had a favorable attitude toward using the computer. This was shown by their increase in interest and their feeling that the computer was the most helpful instructional tool that they used.

The study by DeBlassio reported that the students' attitudes towards using the computer in mathematics courses had a positive relationship with their attitudes toward mathematics and the instructional setting, their mathematics aptitude, programming achievement, and programming experience. No relationship was found between the students' attitudes toward using the computer and their IQ or sex.

In the study by Smith there was no change in the students' self-concept, locus of control, and level of aspiration as a result of using the computer as an instructional tool. However, it was found that the posttest self-concept scores of the computer group were significantly related to their mathematics achievement scores which showed that the use of the computer was effective at alining the self-concept of the students with their mathematics achievement resulting in realistics aspiration levels. The use of the computer as an instructional tool was also given credit for increases in student involvement ("CAI Gets Credit..." and Maser), student interest ("CAI Gets Credit..." and Crawford), student motivational levels (Jhin), and the students' internal control ("CAI Gets Credit...").

The majority of the studies showed an increase in attitudes or less negative attitudes by the computer group. The favorable attitudes could be attributed to the direct and independent form of instruction, a change from the routine classroom work, and the students general rating of their computer experience as interesting and motivating. The negative attitudes reported could be attributed to the lack of use of computer materials by the computer group and program implementation problems.

Summary - Effects on Teacher Attitudes

Three studies reported positive teacher attitudes toward the use of the computer as an instructional tool. The study by Crawford revealed that the teachers felt that the use of the computer in their classrooms increased the level of interest and motivation of the students involved. The teachers involved in the study by Gershman felt that the use of computers increased their workload, but more importantly, increased their teaching effectiveness. Finally, in the three-year study by Maser, the attitudes of the teachers and their involvement increased continually over the duration of the study.

There were two studies which reported negative teacher attitudes. In the study by Sherzer, the teachers did not readily use the computer because they felt that they were not competent enough to use it and that there was not enough time to incorporate the computer lessons into their plans. The negative attitudes of the teachers in the study by Signer resulted from similar feelings. These teachers felt insecure about adapting their methods to the computer materials resulting in their recommendation that the computer should only be used for drill and practice with small groups of students.

Summary - Effects on Student Learning Time

The relation between student learning time and the use of the computer as an instructional tool was reported in five studies. All of these studies reported positive relationships which the majority of the researchers felt were the most significant findings revealed by their studies. In the studies by Edwards, Kulik, and Haberman, it took the

students involved less time to learn the mathematics materials with the use of the computer than with any other method. In fact, in Kulik's meta-analysis one study reported an 88 percent savings in learning time.

Two studies did not report a reduction in student learning time as a result of using the computer, but they did show a positive effect on the learning time of the students involved. The study by Thomas showed that the computer group had higher amounts of total and independent time on task than the control group. In the study by Modisett, the students who used the computer worked almost twice as many problems per day as the students who did not use the computer.

Summary - Effects on Special Student Populations

In the studies that involved special populations of students (Table 1), all but three studies revealed that the use of the computer as an instructional tool had positive effects on the students' mathematics achievement, attitudes, or learning time. Of the three studies that did not report positive findings, the studies by Johnson and Smith which involved white lower-middle class students and Mexican-American low-achievers, showed that the use of the computer had no effect on student achievement and student attitudes respectively. The one study that reported negative findings was conducted by Harman. The results of the study showed that the remedial treatment group that had regular instruction with the use of a microcomputer had a decrease in their attitude toward mathematics.

Five studies reported findings that showed the high amount of effectiveness the computer can have when used as instructional tool in mathematics courses. In the study "CAI Gets Credit...", the students

Table 1

Study	Special Student Population
Burns	disadvantaged
"CAI Gets Credit..."	low-achievers and 80% minority
Crawford	underachieving and disadvantaged
Fletcher	deaf
Gershman	remedial
Haberman	emotionally and socially disturbed
Harman	remedial
Henderson	underachievers
Johnson	white lower-middle class
Maser	economically and educationally disadvantaged
Menis	previous year low-achievers
Modisett	remedial
Smith	low-achievers and 75% Mexican-American
Vincent	EMR (Educable Mentally Retarded)

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involved who were low-achievers and 80% minority, made two years growth in mathematics, had an increase in interest, and were less truant and tardy due to the internal control which the use of the computer taught them. The mathematics achievement levels and the attitude of the underachieving and disadvantaged students involved in the study by Crawford were significantly increased. The students also felt that the computer was the most helpful instructional tool they had used. The deaf students which participated in Fletcher's study had posttest achievement levels that were 2 to 3 times higher than what was expected from classroom instruction. This study also revealed that when a learning task does not involve verbal skills, the performance of deaf children can be as good as normal-hearing children. In the study by Haberman, the computer group had significant gains in mathematics achievement and had a higher amount of total and independent time on task than the group that did not use the computer. Finally, in the five-month study by Modisett, the

remedial students which used the computer had a 10.5 month computational growth as compared to the 4.7 month growth of the students who did not use the computer. The computer group also did almost twice as many problems per day as the group who did not use the computer.

Conclusions

The use of the computer as an instructional tool in secondary mathematics courses has been proven to have many positive effects and very few negative effects. These positive effects included an increase of student achievement and more positive student attitudes towards mathematics, the instructional setting, the instructional method used or to be used, and using the computer, subsequently increasing the students' perception of themselves. The other positive effects were the decrease in learning time or the increase in learning time where it was appropriate such as in the studies by Haberman and Modisett, and the relationship between the use of the computer and special populations of students. These positive effects as a result of using the computer could be attributed to the following factors: 1) immediate feedback; 2) the lack of external variables; 3) the specific directions given to the learner by the computer; 4) the one-to-one teaching relationship; and 5) the success the learner experiences. (Maser 4)

As a result of these positive effects of the use of the computer as an instructional tool, the students involved generally learned more, retained more, or learned the same amount of material faster with more positive attitudes. Most of the studies reported findings on student achievement and attitudes. However, the findings on student learning time was reported unfortunately by very few. As Thomas (111) stated, "Perhaps the most valuable finding in the long run is that many CAI students gain mastery status in a shortened period of time."

The only relatively mixed results concerned the attitudes of the involved mathematics teachers toward the use of the computer as an instructional tool. In the two studies that reported negative teacher

attitudes (Sherzer and Signer), these attitudes were attributed to implementation problems involving machinery malfunctions and the lack of use of computer materials by the teachers due to the lack of teacher training. These attributing factors were also the major disadvantages of the use of the computer as an instructional tool reported. The negative teacher attitudes could easily be reversed by more inservice training and more teacher involvement. As Selden (64) stated, "As always, it is the trainers' responsibility to make the best use of the tools they have to work with." Eventhough these negative teacher attitudes and the causes for them should not be overlooked, the positive feelings of the teachers should be taken into high consideration. As in the study by Gershman, teachers felt that the use of the computer as an instructional tool increased the students' achievement and attitudes along with increasing their teaching effectiveness.

Recommendations

It would be recommended that:

1) The computer should be used as an instructional tool as a secondary method with other proven instructional techniques.

2) Students who will be using the computer should be exposed to a program of computer literacy prior to their computer experience.

3) Teachers should be provided with preservice training involving the computer and its classroom uses. This training should include evaluation of computer programs, computer literacy instruction, and helpful hints on how to best incorporate the computer into their classroom.

BIBLIOGRAPHY

Beck, John J. Jr. "An Analysis of Student Attitude Toward Computer-Assisted Instruction in Nebraska Public High Schools." (Doctoral dissertation, University of Nebraska, 1979). Dissertation Abstracts International, 1979, 40, 3006-A. (18, 44, 45)

Beck, John J. Jr. "The Effects on Attitudes of Anticipated Computer-Assisted Instruction in Selected High School Courses of Study." AEDS Journal, 12.3 (1979): 138-145. (18, 45)

Bell, Frederick H. "Can Computers Really Improve School Mathematics?" Mathematics Teacher, May 1978, 428-433. (1)

Bohrer, Jean. "Use of a Microcomputer in the Teaching of High School Mathematics." Master's Thesis, San Jose State University, August 1981. (ERIC Document Reproduction Service No. ED 211 071). (1)

Burns, Patricia Knight, and William C. Bozeman. "Computer-Assisted Instruction and Mathematics Achievement: Is There a Relationship?" Educational Technology, October 1981, 32-39. (1, 5, 35, 42, 49)

"CAI Gets Credit for Dramatic Achievement Gains for Minorities." Phi Delta Kappan, December 1977, 290-291. (5, 19, 35, 42, 45, 46, 48, 49)

Carpenter, Thomas P., Mary Kay Corbitt, Henry S Kepner Jr., Mary Montgomery Lindquist, and Robert E. Reys. "The Current Status of Computer Literacy: NAEP Results for Secondary Students." Mathematics Teacher, December 1980, 669-673. (3)

Casner, J. L. "A Study of Attitude Toward Mathematics of Eightn Grade Students Receiving Computer-Assisted Instruction and Students Receiving Conventional Classroom Instruction." (Doctoral dissertation, University of Kansas, 1977). Dissertation Abstracts International, 1978, 38, 7106-A. (19, 44, 45)

Chambers, Jack A., and Alfred Bork. "Computer Assisted Learning in U.S. Secondary/Elementary Schools." The Computing Teacher, 8.1 (1980-1981): 50-51. (1)

Crawford, Alan N. "A Pilot Study of Computer-Assisted Drill and Practice in Seventh Grade Remedial Mathematics." California Journal of Educational Research, 21.4 (1970): 170-181. (6, 20, 29, 36, 42, 45, 46, 47, 49)

DeBlassio, John K., and Frederick H. Bell. "Attitudes Toward Computers in High School Mathematics Courses." International Journal of Mathematical Education in Science and Technology, 12.1 (1981): 47-56. (20, 46)

Douglas, Charles H., and John S. Edwards. "Appendix I A Selected Glossary of Terms Useful in Lealing with Computers." In Microcomputers in the Schools. Ed. James L. Thomas. Phoenix: Oryx Press, 1981. (3)

Edwards, Judith, Shirley Norton, Sandra Taylor, Martha Weiss, and Ralph Dusseldorp. "How Effective is CAI? A Review of Research." Educational Leadership, November 1975, 147-153. (6, 32, 42, 47)

Fletcher, J. D., and Patrick Suppes. "The Stanford Project on Computer-Assisted Instruction for Hearing-Impaired Students." Journal of Computer-Based Instruction, 3.1 (1976): 1-12. (7, 36, 42)

Folk, Mike. "Should Your School Get a Microcomputer?" Mathematics Teacher, October 1978, 608-612. (3)

Gerahman, Janis, and Evannah Sakamoto. "Computer-Assisted Remediation and Evaluation: A CAI Project for Ontario Secondary Schools." Educational Technology, March 1981, 40-43. (7, 21, 29, 37, 42, 45, 47, 52)

Good, Carter V., ed. Dictionary of Education. New York: McGraw-Hill Book Company, 1973. (4)

Haberman, Edward Leslie. "Effectiveness of Computer-Assisted Instruction with Socially/Emotionally Disturbed Children." (Doctoral dissertation, University of Pittsburgh, 1977). Dissertation Abstracts International, 1977, 38, 1998-A. (8, 32, 37, 42, 47, 49, 51)

Harman, David J. "Kanawha County Schools/West Virginia University Teacher Corps Project. Research Report." Charleston: Kanawha County Schools, July 1980. (ERIC Document Reproduction Service No. ED 209 266). (8, 21, 38, 42, 44, 45, 48, 49)

Hatfield, Larry Lee. "Computer-Assisted Mathematics: An Investigation of the Effectiveness of the Computer Used as a Tool to Learn Mathematics." (Doctoral dissertation, University of Minnesota, 1969). Dissertation Abstracts International, 1970, 30, 4239-4230-A. (9, 42, 43)

Henderson, Ronald W., and others. "Effects of Interactive Video/Computer Instruction on the Performance of Underachieving Students in Mathematics." Paper presented at the Annual Meeting of the American Educational Research Association, April 1983, Montreal, Canada. (ERIC Document Reproduction Service No. ED 233 690). (9, 22, 38, 42, 45, 49)

Hoffman, Irwin J. "Effects of Computer Application on Generalization Skills and Achievement in a Second Year Algebra Course." (Doctoral dissertation, University of Denver, 1971). Dissertation Abstracts International, 1971, 32, 2856-B. (10, 42)

Jhin, Kyo Ryoon. "A Statistical Comparison of the Effectiveness of Non-tutorial Computer-Aided Instruction and Conventional Teaching of Algebra." (Doctoral dissertation, Auburn University, 1971). Dissertation Abstracts International, 1971, 32, 5734-B. (10, 22, 42, 43, 45, 46)

Johnson, Warner Goodwin. "The Effects of Computer-Assisted Instruction and Programmed Instruction on the Achievement and Attitudes of Ninth Grade General Mathematics Students." (Doctoral dissertation, Temple University, 1974). Dissertation Abstracts International, 1974, 35, 1426-A. (11, 23, 39, 43, 45, 48, 49)

Katz, Saul M. "A Comparison of the Effects of Two Computer Augmented Methods of Instruction with Traditional Methods of Instruction upon Achievement of Algebra Two Students in a Comprehensive High School." (Doctoral dissertation, Temple University, 1971). Dissertation Abstracts International, 1971, 32, 1188-1189-A. (11, 43)

Kieren, Thomas Ervin. "The Computer as a Teaching Aid of Eleventh Grade Mathematics." (Doctoral dissertation, University of Minnesota, 1968). Dissertation Abstracts International, 1969, 29, 3526-3527-A. (12, 42, 43)

Kulik, James A., Robert L. Bangert, and George W. Williams. "Effects of Computer-Based Teaching on Secondary School Students." Journal of Educational Psychology, 75.1 (1983): 19-26. (3, 12, 23, 33, 42, 45, 47, 48)

Maser, Arthur L., and others. "Highline Public Schools Computer-Assisted Instruction Project: A Program to Meet Disadvantaged Students' Individual Needs for Basic Skills Development: Final Report." Seattle: Highline Public Schools, June 1977. (ERIC Document Reproduction Service No. ED 167 114). (13, 24, 30, 39, 42, 45, 46, 47, 49, 51)

Menis, Yosef, Mitchell Snyder, and Ezra Ben-Kohav. "Improving Achievement in Algebra by Means of the Computer." Educational Technology August 1980, 19-22. (13, 24, 40, 42, 44, 49)

Modisett, Douglas Mitchell. "Effects of Computer-Assisted Instruction on Achievement in Remedial Secondary Mathematical Computation." (Doctoral dissertation, Fordham University, 1980). Dissertation Abstracts International, 1980, 40, 5770-A. (14, 33, 40, 42, 48, 49, 51)

Page, G. Terry, and J. B. Thomas. International Dictionary of Education. New York: Nichols Publishing Company, 1977. (3)

Robitaillie, David F., James M. Sherrill, and David M. Kaufman. "The Effects of Computer Utilization on the Achievement and Attitudes of Ninth Grade Mathematics Students." Journal for Research in Mathematics Education, 8.1 (1977): 26-32. (3, 14, 25, 43, 44, 45)

Ronan, Franklin Delano. "A Study of the Effectiveness of a Computer When Used as a Teaching and Learning Tool in High School Mathematics." (Doctoral dissertation, University of Michigan, 1971). Dissertation Abstracts International, 1971, 32, 1264-1265-A. (15, 42, 43)

Saunders, James, and Frederick H. Bell. "Computer-enhanced Algebra Resources: Their Effects on Achievement and Attitudes." International Journal of Mathematical Education in Science and Technology, 11.4 (1980): 465-473. (3, 15, 25, 43, 45)

Selden, Paul, and Norman L. Schultz. "What the Research Says About CAI's Potential." Training, November 1982, 61-62,64. (52)

Seltzer, Robert A. "Computer-Assisted Instruction - What It Can and Cannot Do." American Psychologist, April 1971, 373-377. (4)

Sherzer, Bill. "Where are the Computers?" The Computing Teacher, May 1979, 6-9. (26, 30, 45, 47, 52)

Signer, Barbara. "A Formative and Summative Evaluation of Computer Integrated Instruction." Paper presented at the CBE Research Conference, 1982. (ERIC Document Reproduction Service No. ED 224 716). (3, 16, 26, 31, 43, 45, 47, 52)

Sippl, Charles J., and Charles P. Sippl. Computer Dictionary and Handbook. Indianapolis: Howard W. Sams and Co., Inc., 1972. (3)

Smith, Ian D. "Impact of Computer-Assisted Instruction on Student Attitudes." Journal of Educational Psychology, 64.3 (1973): 366-372. (27, 41, 46, 48, 49)

Spencer, Donald D. The Computer Programmer's Dictionary and Handbook. Waltham, Massachusetts: Blaisdell Publishing Co., 1968. (3)

Thomas, David B. "The Effectiveness of Computer-Assisted Instruction Secondary Schools." AEDS Journal, 12.3 (1979): 103-116. (16, 27, 34, 42, 45, 48, 51)

Thomas, David B., and Donald H. McClain. "Selecting Microcomputers for the Classroom." In Microcomputers in the Schools. Ed. James L. Thomas. Phoenix: Oryx Press, 1981. (3, 4)

Vincent, Albert Thomas. "The Effects of Supplementary Computer-Assisted Instruction on the Mathematics Achievement and Attitude Toward Mathematics of EMR High School Students." (Doctoral dissertation, University of Cincinnati, 1977). Dissertation Abstracts International, 1979, 39, 736-A. (17, 28, 41, 42, 45, 49)